TITLE: Effectiveness of Telerehabilitation in Physical Therapist Practice: An Umbrella and Mapping Review with Meta–Meta-Analysis

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ABSTRACT

Objective. Telerehabilitation is an option that should be adapted as soon as possible in order to face the crisis caused by COVID-19. An umbrella and mapping review with meta–meta-analysis (MMA) of the available scientific evidence was performed to determine if telerehabilitation could be an effective alternative to conventional rehabilitation in physical therapist practice.

Methods. A systematic review of reviews and a synthesis of the findings of all systematic evidence published to date with a visual map and a meta-meta-analysis (MMA) were performed. A systematic search was realized in Cochrane Database of Systematic Reviews (CDSR), MEDLINE (PubMed), and Google Scholar. Two independent reviewers performed a data analysis and assessed the quality of the included reviews, assessing the risk of bias using ROBIS.

Results. Twenty-nine articles that met the inclusion criteria were selected and divided according to the type of patient targeted for rehabilitation (patients with cardiorespiratory, musculoskeletal, and neurological conditions). The MMA regarding physical function between telerehabilitation and usual care rehabilitation did not reveal a statistically significant difference for patients with cardiorespiratory and musculoskeletal conditions. For patients with neurological conditions, the MMA revealed a statistically significant but negligible effect size in 6 reviews in favor of telerehabilitation (standardized mean difference [SMD] = 0.18; 95% CI = 0.03–0.34).

Conclusion. The results of the present review showed that telerehabilitation offers positive clinical results, even comparable to conventional face-to-face rehabilitation approaches.

Impact. The advantages of lower cost and less interference by the rehabilitation processes in patients' daily life could justify implementing telerehabilitation in clinical settings in the COVID-19 era.

[H1] Introduction

In the recent years, telemedicine allows health care professionals to evaluate, diagnose and treat patients in remote locations using telecommunications networks.[1,2] A sub-area of telemedicine is telerehabilitation, which consists of remotely managing rehabilitation using new telecommunication-based practices.[3]

Telerehabilitation has been employed for treating neurological, cardiorespiratory and musculoskeletal dysfunctions and facilitates access to rehabilitation services, regardless of geographical location.[3] Telerehabilitation can enable individual to continue their rehabilitation in their own social/vocational setting and had a potential role in public health emergencies, like the actual pandemic era due to the limited ability for patients to seek in-person rehabilitation services.[2]

A recent systematic review shows that COVID-19 disease will epidemiologically generate a high incidence of disabling functional alterations that will have to be addressed in the post-acute phases by means of telerehabilitation.[4] However, the possible benefits of telerehabilitation in this context, previous reports have already indicated the barriers to implementing e-health content, such as lack of knowledge and the uncertainty regarding the use of technology, and doubts remain as to whether these barriers limit the effectiveness of telerehabilitation and its clinical application.[5–7]

Telerehabilitation is an option that should be adapted as soon as possible to the rehabilitation systems in order to face the current crisis caused by COVID-19 or other pandemics that may occur in the future. For this reason, to thereby improve clinical care in this situation, it seems necessary to determine the effectiveness of telerehabilitation in patients with neurological, cardiorespiratory or musculoskeletal pathologies.[8] In this article, an umbrella and mapping review with meta-meta-analysis (MMA) of the available scientific evidence was performed to determine if telerehabilitation could be an effective alternative to conventional rehabilitation in physical therapist practice.

[H1] METHODS

[H2] Design

A systematic reviews of reviews was conducted, as well as a synthesis of the findings of all systematic evidence published based on Smith et al. (2011).[9]

[H2] Search Strategy

A systematic search was conducted in the following databases for articles published between 1950 and April 15, 2020: Cochrane Database of Systematic Reviews (CDSR), MEDLINE (PubMed) and Google Scholar. The search string was adapted for each database.

Two independent reviewers conducted the search using the same methodology, and differences during this phase were resolved by consensus. The reviewers also manually searched journals that had published related articles, as well as the reference lists of the included studies. The reference sections of the original studies were also manually screened. The Mendeley citation management software was employed (Mendeley desktop v1.17.4, Elsevier, New York, NY, USA) and hand checked the results to remove duplicates.[10]

The comprehensive search was combined the following key terms using Boolean operators: Intervention ("telerehabilitation", "telemedicine", "telehealth", "exercise", "Web rehabilitation", "tecnhology rehabilitation", "computer rehabilitation", "phone rehabilitation", "function") and Review type ("systematic review", "meta-analysis ", "review literature", "qualitative systematic review").

[H2] Inclusion Criteria

The selection criteria for this review were based on methodological and clinical factors, specifically the population, intervention, comparison, outcomes and study type (PICOS) criteria.[11]

[H3] Population

The participants selected for the published studies were older than 18 years and included patients with musculoskeletal, cardiac, respiratory, or neurological diseases. The patients' sex was irrelevant.

[H3] Intervention and Control

The intervention was the telerehabilitation approach. telerehabilitation was considered as any technology (wearable devices, Internet, virtual reality, telephone) that enabled the monitoring or execution of physical therapy rehabilitation, remotely controlled using telecommunication-based practices. Therapy could be focused on physical or cognitive ability. The intervention could be provided as an independent intervention, added to therapy or embedded in the therapy (eg, standard care or standard therapy). Comparator groups could be standard care, face-to-face rehabilitation and conventional therapy.

[H3] Outcomes

The measures used to assess the results and effects were any kind of variable related to clinical outcomes, especially physical functioning, as well as health-related quality of life (HRQL).

[H3] Study Design

Systematic reviews with or without metanalysis.

[H2] Selection Criteria and Data Extraction

First, the two independent reviewers performed a data analysis, assessing the relevance of the reviews regarding the study questions and objectives. This initial analysis was performed based on information from each study's title, abstract, and keywords.

If there was no consensus or if the abstracts did not contain enough information, the full text was reviewed. The second phase of the analysis using the full text was performed to assess whether the studies met all of the inclusion criteria. Differences between the reviewers were resolved by discussion and consensus moderated by a third reviewer [12] (Fig. 1). The data described in the results were extracted by means of a structured protocol that ensured that the most relevant information was obtained from each study. [13]

[H2] Assessment of Methodological Quality

The two independent reviewers assessed the quality of the included reviews, assessing the risk of bias using ROBIS,[14] which evaluates the quality across 4 domains: 1) study eligibility; 2) study identification and selection; 3) data collection and study appraisal; and 4) synthesis and findings. ROBIS provides an overall risk of bias for the review as high, low or unclear. The two independent reviewers examined the quality of the selected studies using the same methodology; disagreements between the reviewers were resolved by consensus with a third reviewer. The inter-rater reliability was determined using a kappa coefficient (>0.7 indicated a high level of agreement between the assessors, 0.5–0.7 indicated a moderate level of agreement, and <0.5 indicated a low level of agreement).

A further quality assessment was conducted using the Quality Assessment Scale for Systematic Reviews developed by Barton et al.[15] This 13-item scale (with criteria rated from 0 to 2) was found to be a valid and reliable tool for assessing the methodological quality of systematic reviews. The developers of the scale provide a cut-off score for high-quality reviews (>20 out of a possible 26).[15] This evaluation is no longer conducted in a peer-to-peer and independent manner, and only one evaluator evaluated the methodological quality.

[H2] Data Synthesis and Analysis

The statistical analysis using meta-analyses with interactive explanations was performed (MIX 1.7; BiostatXL). [16]

The same inclusion criteria for the review was employed, but 2 criteria were added: 1) The Results section contained detailed information on the comparative statistical data (mean, standard deviation, and/or 95% CI) of the main variables, and 2) data for the analyzed variables were represented in at least 2 studies. The summary statistics in the form of forest plots were presented, [17] which consist of a weighted compilation of all standardized mean differences (SMDs) and corresponding 95% CI reported by each study and provide an indication of heterogeneity among the studies.

The statistical significance of the pooled SMDs were examined using Hedges' *g* to account for a possible overestimation of the true population effect size in small studies [18]. The magnitude of *g* was interpreted according to a 4-point scale: 1) <0.20, negligible effect; 2) 0.20–0.49, small effect; 3) 0.50–0.79, moderate effect; and 4) ≥0.80, large effect. [19] The degree of heterogeneity among the studies were estimated by employing Cochran Q statistic test ($P < .1$ was considered significant) and the inconsistency index (I^2). [20] An I^2 >25% is considered to represent low heterogeneity, while an I^2 >50% is considered medium, and an I^2 >75% is considered to represent large heterogeneity. [21] The I^2 index is complementary to the Q test, although it has a similar problem with power as does the Q test with a small number of studies. [21] A study was therefore considered heterogeneous when it fulfilled one or both of the following conditions: 1) the Q test was significant ($P < .1$), and 2) the result of I^2 was >75%. To obtain a pooled estimate of the effect in the meta-analysis of the heterogeneous studies, a random-effects model was performed, as described by DerSimonian and Laird.[22]

[H2] Evidence Map

A visual map of the scientific evidence of each systematic review was created to visually display the information of each review and included 4 dimensions based on the map created by Miake-Lye et al.[23]

1. Number of items (bubble size): The number of items in each included revision is represented proportionally by the size of the bubble.

2. Study population (bubble color): The study population will be determined from each bubble's color.

3. Effect (x-axis): The authors classified each review according to the effects found. When the intervention group showed greater benefits than the control group, the intervention was classified as "potentially better"; otherwise, the intervention was classified as "potentially worse". When there was insufficient evidence, the intervention was classified as "unclear". If there were no differences, the intervention was included as "no differences". If there were contradictory results, we included the intervention as "mixed results".

4. Strength of findings (y-axis): The reviews were sorted into the following 5 categories according to the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) approach: high strength of evidence, moderate strength of evidence, low strength of evidence, very low strength of evidence, or unable to

determine the strength of evidence. If each article explicitly provided its level of recommendation, this was added. If it was not explicitly reported, this was inferred by the researchers of this article. If it was not possible to determine (due to lack of information) the studies were classified as “unsettled”.

[H1] RESULTS

Twenty-three articles that met the inclusion criteria were selected and divided them according to the type of patient targeted for rehabilitation (cardiac or respiratory; musculoskeletal or postoperative and neurological telerehabilitation). The characteristics of the studies from which data were extracted (sample size, demographic characteristic, intervention, outcomes, main results and conclusions) are presented in the **Supplementary Table**.

[H2] Study Population Characteristics

A set of five reviews evaluated telerehabilitation for patients with cardiorespiratory diseases, which included mostly cardiac events, cardiovascular disease and chronic obstructive pulmonary disease.

Seven reviews were included on the use of telerehabilitation for patients with musculoskeletal disorders or who had recently undergone surgery. The main conditions for the patients with musculoskeletal disorders were chronic pain, rheumatoid arthritis and osteoarthritis. The most common operations were knee arthroplasties, knee and hip replacements and orthopedic operations. Thirteen reviews were included that evaluated the efficacy of telerehabilitation for patients with neurological diseases, the most frequent of which were multiple sclerosis, stroke, acquired brain damage, Alzheimer’s disease and traumatic brain injury.

[H2] Interventions

All interventions were based on telerehabilitation, either in isolation or combined with classical rehabilitation. Telerehabilitation was considered any technology (wearable devices, internet, virtual reality, telephone) that allowed for the monitoring or execution of rehabilitation or therapy.

The aim of the interventions was to increase motor function or physical capacity using telerehabilitation-based home exercise protocols. The interventions consisted of repeated motor tasks or exercises, balance exercises and motor re-education or aerobic exercises. It was also included education-based interventions that sought to promote changes in lifestyle or health behaviors.

[H2] Outcomes

The main variables of interest in the various reviews differed according to the types of patients included. The reviews that focused on cardiac and respiratory telerehabilitation assessed physical function and capacity, adverse events, dyspnea and HRQL. At musculoskeletal level, the main variables analyzed were physical function, pain, disability and HRQL. The reviews that analyzed patients with neurological disorders assessed motor and cognitive function, disability, independence for activities of daily living and HRQL. Many of the reviews evaluated aspects related to the implementation of telerehabilitation, such as satisfaction with therapy and cost-effectiveness.

[H2] Methodological Quality Assessment

Regarding the methodological quality, the agreement between the two evaluators was high, according to the kappa coefficient ($\kappa = 0.88$). The risk of bias of the included reviews is shown in Table 1 and Figure 2, and the methodological quality assessment is presented in Table 2.

[H2] Findings

[H3] Cardiorespiratory Telerehabilitation

Five systematic reviews with meta-analyses evaluated the efficacy of telerehabilitation for patients with cardiac and respiratory diseases and included 34 primary studies. Regarding physical function, four reviews showed similar results between telerehabilitation and usual care interventions [24–27] and one review showed better results for telerehabilitation intervention.[28] However, the strength of findings was unclear (Fig. 3).

With regard to the quantitative analysis, the MMA of physical function did not reveal a statistically significant difference in 2 reviews (SMD = 0.03; 95% CI = -0.15 to 0.22; *P* = .07) without evidence of significant heterogeneity (Q = 1.31; *P* = .25, I^2 = 24%) **(Suppl. Material 1)**.

[H3] Musculoskeletal Telerehabilitation

Seven reviews evaluated the role of telerehabilitation in patients with musculoskeletal conditions and included 71 primary studies. Regarding physical function, seven reviews showed no differences between telerehabilitation and usual care interventions, with very low to moderate-high evidence (Fig. 3). [29–35] One review could not draw conclusions and showed unclear results in patients with rheumatoid arthritis.[36] Finally, Agostini et al., showed better results in terms of functionality for telerehabilitation compared to usual care in patients with knee arthroplasty.[28]

With regard to the quantitative analysis, the MMA of physical function did not reveal a statistically significant difference in 3 reviews (SMD = 0.00; 95% CI = -0.44 to 0.44; *P* = .07) with evidence of significant heterogeneity (Q = 18.61; *P* < .01; I^2 = 89%) **(Suppl. Material 2)**.

[H3] Neurological Telerehabilitation

Thirteen systematic reviews, including 172 primary studies, evaluated the efficacy of telerehabilitation for patients with neurological disorders, although there was a high level of heterogeneity between the patients and between the interventions. Regarding physical function, 12 reviews showed similar results between telerehabilitation interventions and usual care, with low to moderate evidence.[28,35-45] However Laver et al[46] found insufficient evidence to determine the effectiveness of telerehabilitation on functional variables (Fig. 3).

With regard to the quantitative analysis, the MMA of physical function revealed a statistically significant but negligible effect size in 6 reviews in favor of telerehabilitation (SMD = 0.18; 95% CI = 0.03–0.34; *P* < .001) and without evidence of significant heterogeneity (Q = 4.96, *P* = .04, I^2 = 0%) **(Suppl. Material 3)**. The shape of the funnel plot appeared to be symmetrical in the dominant model. The sensitivity exclusion analysis suggested that no review significantly affected the pooled SMD. Egger test results suggested significant evidence of publication bias in the analysis (SE = 0.05; *z* = 8.61; *P* = .02). In addition, the MMA regarding daily live function did not reveal a statistically significant difference in 5 reviews (SMD = -0.02; 95% CI = -0.11 to 0.06; *P* = .6) without evidence of significant heterogeneity (Q = 0.68, *P* = .95; I^2 = 0%) **(Suppl. Material 4)**.

[H1] DISCUSSION

The results of this review showed that telerehabilitation offers positive clinical results and similar conventional face-to-face rehabilitation approaches regarding physical function, with very low to moderate-high evidence in patients with neurological and musculoskeletal conditions, and unclear for patients with cardiac and respiratory conditions. In addition, results of quantitative analysis did not show differences between both interventions and showed statistically significant results in favor of telerehabilitation regarding physical function in patients with neurological disorders.

Regarding the results shown in the MMA, differences in the type of patient targeted for rehabilitation were found. In the case of neurological disorders, the main condition studied was stroke. However, the reviews that assessed cardiorespiratory and musculoskeletal telerehabilitation presented greater variability in the included conditions, which could influence the results.

Therefore, it seems that telerehabilitation could be a better treatment option in patients with neurological conditions, although further research would be needed to investigate its effectiveness in other types of disorders. In this regard, some aspects of telerehabilitation may be particularly positive in patients with neurological disorders, compared to patients with cardiorespiratory and musculoskeletal conditions. Firstly, patients with neurological disorders usually require high doses of treatment to obtain functional improvements.[47] This is difficult to achieve through of face-to-face interventions due to lack of time; however, telerehabilitation would facilitate increasing the intervention time. Secondly, telerehabilitation allows the training of functional tasks in the patient's usual environment rather than in clinical settings, favouring their transfer to daily life, a fundamental aspect in patients with neurological pathology. [48]

There are, however, a number of barriers and obstacles that still need to be considered. Despite the theoretical advantages of telerehabilitation over conventional rehabilitation, few studies have evaluated patient satisfaction or acceptance of this type of rehabilitation, and those studies have found conflicting results for this variable. Further studies are needed to evaluate the cost-effectiveness of this rehabilitation model, the barriers encountered by patients when performing telerehabilitation and the patients' acceptance of the model. Most of the included studies used telerehabilitation systems based on telephone contact or video conferencing. However, a number of these systems employed more complex technologies that required virtual reality devices or inertial sensors, requiring patients to have sufficient infrastructure to perform the therapy, which can be difficult and increase costs due to the use of more complex technologies, which limits access to telerehabilitation services. In addition, health professionals also need adequate training to properly use these technologies. Some patients targeted for this type of rehabilitation are cognitively impaired, which can also hinder the clinical transfer of telerehabilitation. Aspects such as privacy and data protection also need to be considered when applying this rehabilitation model.

One of the critical thighs about telerehabilitation is that requires patients to be involved and committed to therapy to ensure compliance with the intervention. Establishing strong therapist-patient relationships through online technology requires a patient-focused telerehabilitation, with proper communication and the establishment of objectives and tasks through joint decision making. Peretti et al. (2017)[3] suggested that one of the limitations of telerehabilitation is patient skepticism about remote interaction with therapists, thereby necessitating further research and teaching efforts on this therapeutic approach.

It is imperative also consider the patient's perspective, given that individuals might be distrustful of telerehabilitation, due to their discomfort with using new technologies, their lack of knowledge and their negative expectations regarding telerehabilitation. It is necessary to increase patients' confidence through educational strategies implemented by health professionals or through technological training before starting the rehabilitation. As a number of studies have suggested, the perceived benefit of using technology, in addition to receiving appropriate technical support, appears to affect the patient's engagement in telerehabilitation.[49] Social education is therefore needed to standardize and enhance the value of telerehabilitation as a safe and effective model in health care, and health professionals and health authorities need to be involved.[50]

[H2] Limitations

This study presents a number of limitations. First, many of the included studies presented low methodological quality and a high risk of bias. The results should therefore be analyzed with caution. Second, there was considerable variability between the systematic reviews in terms of the interventions as well as the endpoints used for the evaluation. It was also not possible to conduct a quantitative analysis on certain variables due to the paucity of comparable studies. Lastly, the quantitative results of the MMA have shown the presence of high heterogeneity, which should be considered an important limitation. Future studies should study the efficacy of telerehabilitation with greater methodological rigor, as well as studying its effect on other populations such as pediatric patients or patients with cancer.

[H1] CONCLUSIONS

The results of the present review showed that telerehabilitation offers positive clinical results regarding physical function and even comparable with conventional face-to-face rehabilitation approaches, especially in patients with neurological conditions. The advantages of lower cost and less interference by the rehabilitation processes in patients' daily life, could justify implementing telerehabilitation in clinical settings in the COVID-19 era.

However, it must be borne in mind that prescribing exercise in patients is a complex process and requires advanced therapeutic skills to increase adherence and effectiveness such as patient education and communication. For this reason, the adaptation of telerehabilitation to the usual practice of physical therapy has to be done through a change of paradigm in to ensure an effective patient based telerehabilitation.

Author Contributions

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Systematic Review Registration

This meta–meta-analysis was not registered.

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The authors completed the ICMJE Form for Disclosure of Potential Conflicts of Interest and reported no conflicts of interest.

REFERENCES

1. Zampolini M, Todeschini E, Guitart MB, et al. Tele-rehabilitation: Present and future. *Ann Ist Super Sanita*. 2008;44(2):125-134.
2. Seelman KD, Hartman LM. Telerehabilitation: Policy Issues and Research Tools. *Int J Telerehabilitation*. 2009;1(1):47-58. doi:10.5195/ijt.2009.6013
3. Peretti A, Amenta F, Tayebati SK, Nittari G, Mahdi SS. Telerehabilitation: Review of the State-of-the-Art and Areas of Application. *JMIR Rehabil Assist Technol*. 2017;4(2):e7. doi:10.2196/rehab.7511
4. de Sire A, Andrenelli E, Negrini F, Negrini S, Ceravolo M. Systematic Rapid Living Review on Rehabilitation Needs Due to Covid-19: Update to April 30th 2020. *Eur J Phys Rehabil Med*. 2020. doi:10.23736/S1973-9087.20.06378-9
5. Gray K, Sim J. Factors in the development of clinical informatics competence in early career health sciences professionals in Australia: A qualitative study. *Adv Heal Sci Educ*. 2011;16(1):31-46. doi:10.1007/s10459-010-9238-3
6. Buckeridge DL, Goel V. Medical informatics in an undergraduate curriculum: a qualitative study. *BMC Med Inform Decis Mak*. 2002;2(1). doi:10.1186/1472-6947-2-6
7. Wentink MM, Siemonsma PC, van Bodegom-Vos L, et al. Teachers' and students' perceptions on barriers and facilitators for eHealth education in the curriculum of functional exercise and physical therapy: a focus groups study. *BMC Med Educ*. 2019;19(1):343. doi:10.1186/s12909-019-1778-5
8. Frenk J, Chen L, Bhutta ZA, et al. Health professionals for a new century: Ttransforming education to strengthen health systems in an interdependent world. *Lancet*. 2010;376(9756):1923-1958. doi:10.1016/S0140-6736(10)61854-5

9. Smith V, Devane D, Begley CM, Clarke M. Methodology in conducting a systematic review of systematic reviews of healthcare interventions. *BMC Med Res Methodol*. 2011;11(1):15. doi:10.1186/1471-2288-11-15

10. Kwon Y, Lemieux M, McTavish J, Wathen N. Identifying and removing duplicate records from systematic review searches. *J Med Libr Assoc*. 2015;103(4):184-188. doi:10.3163/1536-5050.103.4.004

11. Stone PW. Popping the (PICO) question in research and evidence-based practice. *Appl Nurs Res*. 2002;15(3):197-198. doi:10.1053/apnr.2002.34181

12. Furlan AD, Pennick V, Bombardier C, van Tulder M. 2009 updated method guidelines for systematic reviews in the Cochrane Back Review Group. *Spine (Phila Pa 1976)*. 2009;34(18):1929-1941. doi:10.1097/BRS.0b013e3181b1c99f

13. Higgins J, Green S. *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0[M]*. Chichester: Wiley-Blackwell; 2008.

14. Whiting P, Savović J, Higgins JPT, et al. ROBIS: A new tool to assess risk of bias in systematic reviews was developed. *J Clin Epidemiol*. 2016;69:225-234. doi:10.1016/j.jclinepi.2015.06.005

15. Barton CJ, Webster KE, Menz HB. Evaluation of the scope and quality of systematic reviews on nonpharmacological conservative treatment for patellofemoral pain syndrome. *J Orthop Sports Phys Ther*. 2008;38(9):529-541. doi:10.2519/jospt.2008.2861

16. Bax L, Yu LM, Ikeda N, Tsuruta H, Moons KGM. Development and validation of MIX: Comprehensive free software for meta-analysis of causal research data. *BMC Med Res Methodol*. 2006;6(50):1-11. doi:10.1186/1471-2288-6-50

17. Lewis S, Clarke M. Forest plots: Trying to see the wood and the trees. *Br Med J*. 2001;322(7300):1479-1480. doi:10.1136/bmj.322.7300.1479

18. Hedges L V. Estimation of effect size from a series of independent experiments. *Psychol Bull*. 1982;92(2):490-499. doi:10.1037/0033-2909.92.2.490

19. Cohen J. A power primer. *Psychol Bull*. 1992;112(1):155-159. doi:10.1037/0033-2909.112.1.155

20. Higgins JPT, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ*. 2003;327(7414):557-560. doi:10.1136/bmj.327.7414.557

21. Huedo-Medina TB, Sánchez-Meca J, Marín-Martínez F, Botella J. Assessing heterogeneity in meta-analysis: Q statistic or I^2 index? *Psychol Methods*. 2006;11(2):193-206. doi:10.1037/1082-989X.11.2.193

22. DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials*. 1986;7(3):177-188. doi:10.1016/0197-2456(86)90046-2

23. Miake-Lye IM, Mak S, Lee J, et al. Massage for Pain: An evidence map. *J Altern Complement Med*. 2019;25(5):475-502. doi:10.1089/acm.2018.0282

24. Huang K, Liu W, He D, et al. Telehealth interventions versus center-based cardiac rehabilitation of coronary artery disease: A systematic review and meta-analysis. *Eur J Prev Cardiol*. 2015;22(8):959-971. doi:10.1177/2047487314561168

25. Wu C, Li Y, Chen J. Hybrid versus traditional cardiac rehabilitation models: a systematic review and meta-analysis. *Kardiol Pol*. 2018;76(12):1717-1724. doi:10.5603/KP.a2018.0175

26. Chan C, Yamabayashi C, Syed N, Kirkham A, Camp PG. Exercise telemonitoring and telerehabilitation compared with traditional cardiac and pulmonary rehabilitation: A systematic review and meta-analysis. *Physiother Canada*. 2016;68(3):242-251. doi:10.3138/ptc.2015-33

27. Lundell S, Holmner Å, Rehn B, Nyberg A, Wadell K. Telehealthcare in COPD: A systematic review and meta-analysis on physical outcomes and dyspnea. *Respir Med*. 2015;109(1):11-26. doi:10.1016/j.rmed.2014.10.008

28. Agostini M, Moja L, Banzi R, et al. Telerehabilitation and recovery of motor function: a systematic review and meta-analysis. *J Telemed Telecare*. 2015;21(4):202-213. doi:10.1177/1357633X15572201

29. Cottrell MA, Galea OA, O'Leary SP, Hill AJ, Russell TG. Real-time telerehabilitation for the treatment of musculoskeletal conditions is effective and comparable to standard practice: A systematic review and meta-analysis. *Clin Rehabil*. 2017;31(5):625-638. doi:10.1177/0269215516645148

30. Grona SL, Bath B, Busch A, Rotter T, Trask C, Harrison E. Use of videoconferencing for physical therapy in people with musculoskeletal conditions: A systematic review. *J Telemed Telecare*. 2018;24(5):341-355. doi:10.1177/1357633X17700781

31. Jiang S, Xiang J, Gao X, Guo K, Liu B. The comparison of telerehabilitation and face-to-face rehabilitation after total knee arthroplasty: A systematic review and meta-analysis. *J Telemed Telecare*. 2018;24(4):257-262. doi:10.1177/1357633X16686748

32. Shukla H, Nair SR, Thakker D. Role of telerehabilitation in patients following total knee arthroplasty: Evidence from a systematic literature review and meta-analysis. *J Telemed Telecare*. 2016;23(2):339-346. doi:10.1177/1357633X16628996

33. Pastora-Bernal JM, Martín-Valero R, Barón-López FJ, Estebanez-Pérez MJ. Evidence of benefit of telerehabitation after orthopedic surgery: A systematic review. *J Med Internet Res*. 2017;19(4). doi:10.2196/jmir.6836

34. Wang X, Hunter DJ, Vesentini G, Pozzobon D, Ferreira ML. Technology-assisted rehabilitation following total knee or hip replacement for people with osteoarthritis: A systematic review and meta-analysis. *BMC Musculoskelet Disord*. 2019;20(1). doi:10.1186/s12891-019-2900-x

35. Corti C, Oldrati V, Oprandi MC, et al. Remote technology-based training programs for children with acquired brain injury: A systematic review and a meta-analytic exploration. *Behav Neurol*. 2019;2019. doi:10.1155/2019/1346987

36. Tchero H, Teguo MT, Lannuzel A, Rusch E. Telerehabilitation for stroke survivors: Systematic review and meta-analysis. *J Med Internet Res*. 2018;20(10):e10867. doi:10.2196/10867

37. Schröder J, van Criekinge T, Embrechts E, et al. Combining the benefits of tele-

rehabilitation and virtual reality-based balance training: a systematic review on feasibility and effectiveness. *Disabil Rehabil Assist Technol*. 2019;14(1):2-11. doi:10.1080/17483107.2018.1503738

38. Rintala A, Hakala S, Paltamaa J, Heinonen A, Karvanen J, Sjögren T. Effectiveness of technology-based distance physical rehabilitation interventions on physical activity and walking in multiple sclerosis: a systematic review and meta-analysis of randomized controlled trials. *Disabil Rehabil*. 2018;40(4):373-387. doi:10.1080/09638288.2016.1260649

39. Rintala A, Päivärinne V, Hakala S, et al. Effectiveness of Technology-Based Distance Physical Rehabilitation Interventions for Improving Physical Functioning in Stroke: A Systematic Review and Meta-analysis of Randomized Controlled Trials. *Arch Phys Med Rehabil*. 2019;100(7):1339-1358. doi:10.1016/j.apmr.2018.11.007

40. Ownsworth T, Arnautovska U, Beadle E, Shum DHK, Moyle W. Efficacy of Telerehabilitation for Adults with Traumatic Brain Injury: A Systematic Review. *J Head Trauma Rehabil*. 2018;33(4):E33-E46. doi:10.1097/HTR.0000000000000350

41. Laver KE, Adey-Wakeling Z, Crotty M, Lannin NA, George S, Sherrington C. Telerehabilitation services for stroke. *Cochrane Database Syst Rev*. 2020;2020(1). doi:10.1002/14651858.CD010255.pub3

42. Johansson T, Wild C. Telerehabilitation in stroke care - A systematic review. *J Telemed Telecare*. 2011;17(1):1-6. doi:10.1258/jtt.2010.100105

43. Cotelli M, Manenti R, Brambilla M, et al. Cognitive telerehabilitation in mild cognitive impairment, Alzheimer's disease and frontotemporal dementia: A systematic review. *J Telemed Telecare*. 2019;25(2):67-79. doi:10.1177/1357633X17740390

44. Chen J, Jin W, Zhang XX, Xu W, Liu XN, Ren CC. Telerehabilitation Approaches for Stroke Patients: Systematic Review and Meta-analysis of Randomized Controlled Trials. *J Stroke Cerebrovasc Dis*. 2015;24(12):2660-2668. doi:10.1016/j.jstrokecerebrovasdis.2015.09.014

45. Appleby E, Gill ST, Hayes LK, Walker TL, Walsh M, Kumar S. Effectiveness of telerehabilitation in the management of adults with stroke: A systematic review. Cheungpasitporn W, ed. *PLoS One*. 2019;14(11):e0225150. doi:10.1371/journal.pone.0225150

46. Laver KE, Schoene D, Crotty M, George S, Lannin NA, Sherrington C. Telerehabilitation services for stroke. *Cochrane Database Syst Rev*. 2013;2013(12). doi:10.1002/14651858.CD010255.pub2

47. Lohse KR, Lang CE, Boyd LA. Is more better? Using metadata to explore dose-response relationships in stroke rehabilitation. *Stroke*. 2014;45(7):2053-2058. doi:10.1161/STROKEAHA.114.004695

48. Gorman C, Gustafsson L. The use of augmented reality for rehabilitation after stroke: a narrative review. *Disabil Rehabil Assist Technol*. 2020;14:1-9. doi:10.1080/17483107.2020.1791264

49. Hamilton C, McCluskey A, Hassett L, Killington M LM. Patient and therapist experiences of using affordable feedback-based technology in rehabilitation: a qualitative study nested in a randomized controlled trial. - Abstract - Europe PMC.

50. Greenhalgh T, Procter R, Wherton J, Sugarhood P, Shaw S. The organising vision for telehealth and telecare: Discourse analysis. *BMJ Open*. 2012;2(4):e001574. doi:10.1136/bmjopen-2012-001574

TABLES

Table 1. Risk of bias assessment in systematic reviews through ROBIS scale[a]

Study	Phase 2				Phase 3
	1. Study Eligibility Criteria	2. Identification and Selection of Studies	3. Data Collection and Study Appraisal	4. Synthesis and Findings	Risk in the Bias of Review
Agostini et al 2015[28]	L	L	L	L	L
Appleby et al 2019[45]	L	L	L	L	L
Chan et al 2016[26]	L	L	L	L	L
Chen et al 2015[44]	L	L	L	L	L
Corti et al 2019[35]	L	L	L	L	L
Cotelli et al 2019[43]	L	L	L	L	L
Cottrell et al 2017[29]	L	L	L	L	L
Grona et al 2018[30]	L	H	L	L	L
Huang et el 2015[24]	L	L	L	L	L
Jiang et al 2018[31]	L	L	H	L	L
Johansson & Wild 2011[42]	L	H	H	L	H
Laver et al 2013[46]	L	L	L	L	L
Laver et al 2020[41]	L	L	L	L	L
Lundell et al 2015[27]	L	L	L	L	L
Ownsworth	L	L	L	L	L

et al 2018[40]					
Pastora-Bernal et al 2017[33]	L	H	L	L	L
Rintala et al 2018[38]	L	L	L	L	L
Rintala et al 2019[39]	L	L	L	L	L
Schröder et al 2019[37]	L	L	L	L	L
Shukla et al 2016[32]	L	H	L	L	L
Tchero et al 2018[36]	L	L	L	L	L
Wang et al 2019[34]	L	L	L	L	L
Wu, Li & Chen 2018[25]	L	L	H	L	L

[a] L = low concern; H = high concern; U = unclear concern.

Table 2. Quality Assessment Scores[a]

Study	1	2	3	4	5	6	7	8	9	10	11	12	13	Score
Agostini et al 2015[28]	2	2	2	2	2	2	2	2	2	2	2	2	0	24
Appleby et al 2019[45]	2	2	2	2	0	2	2	2	2	2	2	2	2	22
Chan et al 2016[26]	2	2	0	2	0	2	2	0	2	2	2	2	0	20
Chen et al 2015[44]	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Corti et al 2019[35]	2	2	2	2	0	2	2	2	2	2	2	2	0	22
Cotelli et al 2019[43]	2	2	2	2	0	2	2	2	2	2	2	2	0	22
Cottrell et al 2017[29]	2	2	2	2	2	2	2	2	2	2	2	2	0	24
Grona et al 2018[30]	2	2	2	2	0	2	2	2	2	2	2	2	0	22
Huang et el 2015[24]	2	2	2	2	2	2	2	2	2	2	2	2	0	24
Jiang et al 2018[31]	2	2	2	2	2	2	2	2	2	2	2	2	0	22
Johansson & Wild 2011[42]	2	2	0	2	0	2	2	0	1	2	2	2	2	19
Laver et al 2013[46]	2	2	2	2	2	2	2	2	2	2	2	2	0	24
Laver et al 2020[41]	2	2	2	2	2	2	2	2	2	2	2	2	2	26
Lundell et al 2015[27]	2	2	2	2	0	2	2	2	2	2	2	2	0	22
Ownsworth et al 2018[40]	2	2	2	2	0	2	2	2	2	2	2	2	0	22
Pastora-Bernal et al 2017[33]	2	2	2	2	2	2	2	2	2	2	2	2	2	26

Rintala et al 2018[38]	2	2	2	2	1	2	2	2	2	2	2	2	0	23
Rintala et al 2019[39]	2	2	2	2	1	2	2	2	2	2	2	2	2	25
Schröder et al 2019[37]	2	2	2	2	1	2	2	2	2	2	2	2	2	25
Shukla et al 2016[32]	2	2	0	2	0	2	2	2	2	2	2	2	0	20
Tchero et al 2018[36]	2	2	2	2	2	2	2	2	2	2	2	2	0	24
Wang et al 2019[34]	2	2	0	2	2	2	2	2	2	2	2	2	2	24
Wu, Li & Chen 2018[25]	2	2	2	2	0	2	2	0	0	2	2	2	0	18

[a] 1. Explicitly described to allow replication (ie, 100% confident that you could replicate it). If explained but you can't be 100% confident of replication = in part? 2. Adequate number and range of databases. 3. Alternative searches 4. Adequate range of key words 5. Non-English language papers included in the search. 6. Explicitly of inclusion criteria described to allow replication 7. Excludes reviews which do not adequately address inclusion. 8. Two independent reviewers assessing selection bias. 9. Explicitly of quality assessment described to allow replication.? 10. Meta-analysis conducted on only homogenous data or limitations to homogeneity discussed 11. Confidence intervals/effect sizes reported where possible 12. Conclusions supported by the meta-analysis or other data analysis findings (effect sizes, confidence intervals, etc) in the review. 13. Conclusions address levels of evidence for each intervention/comparison Scoring: 2 = yes; 1 = in part, 1; 0 = no.

FIGURE LEGEND

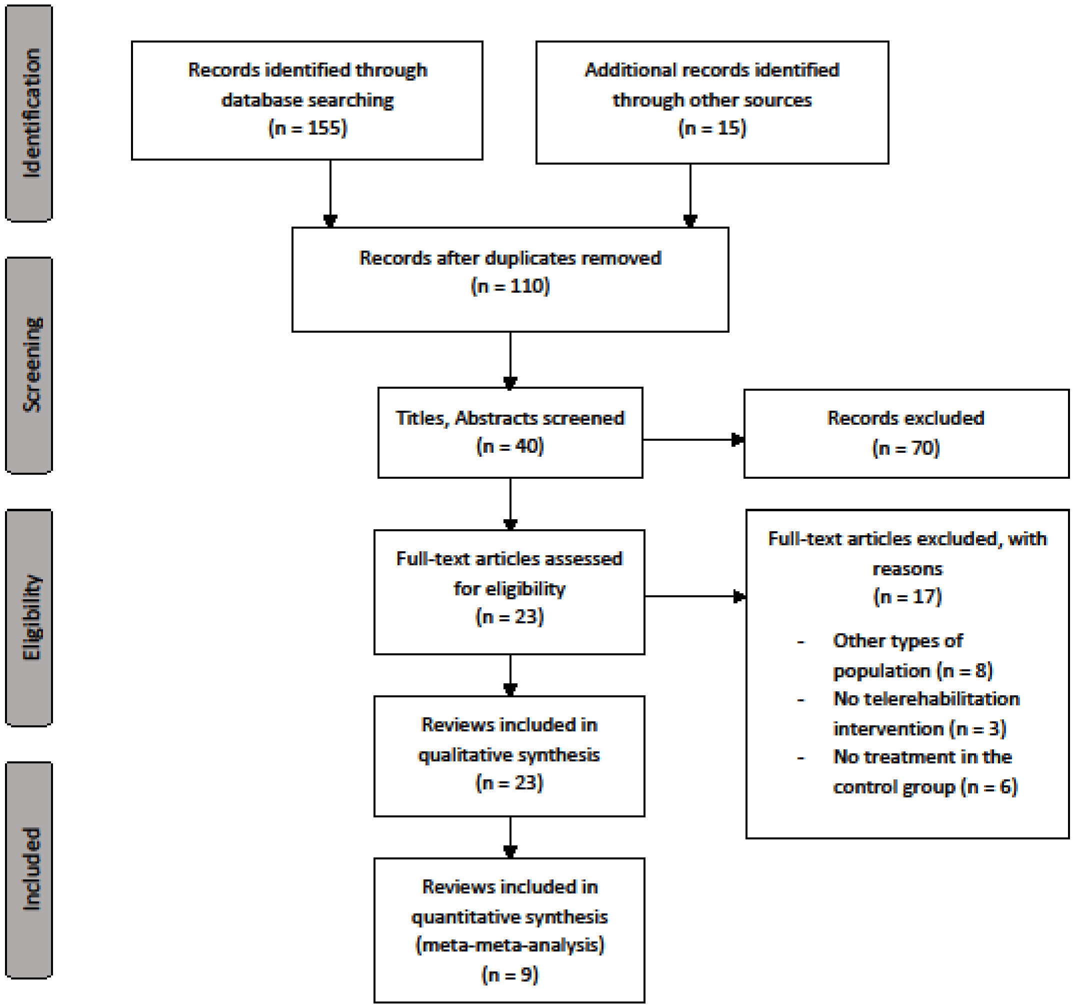

Figure 1. PRISMA flow-chart diagram

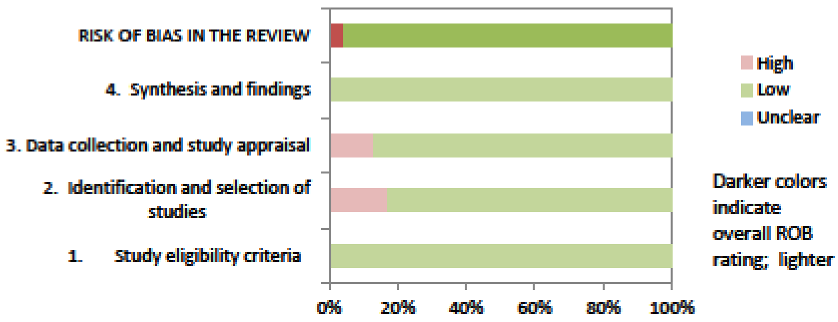

Figure 2. ROBIS risk of bias graph

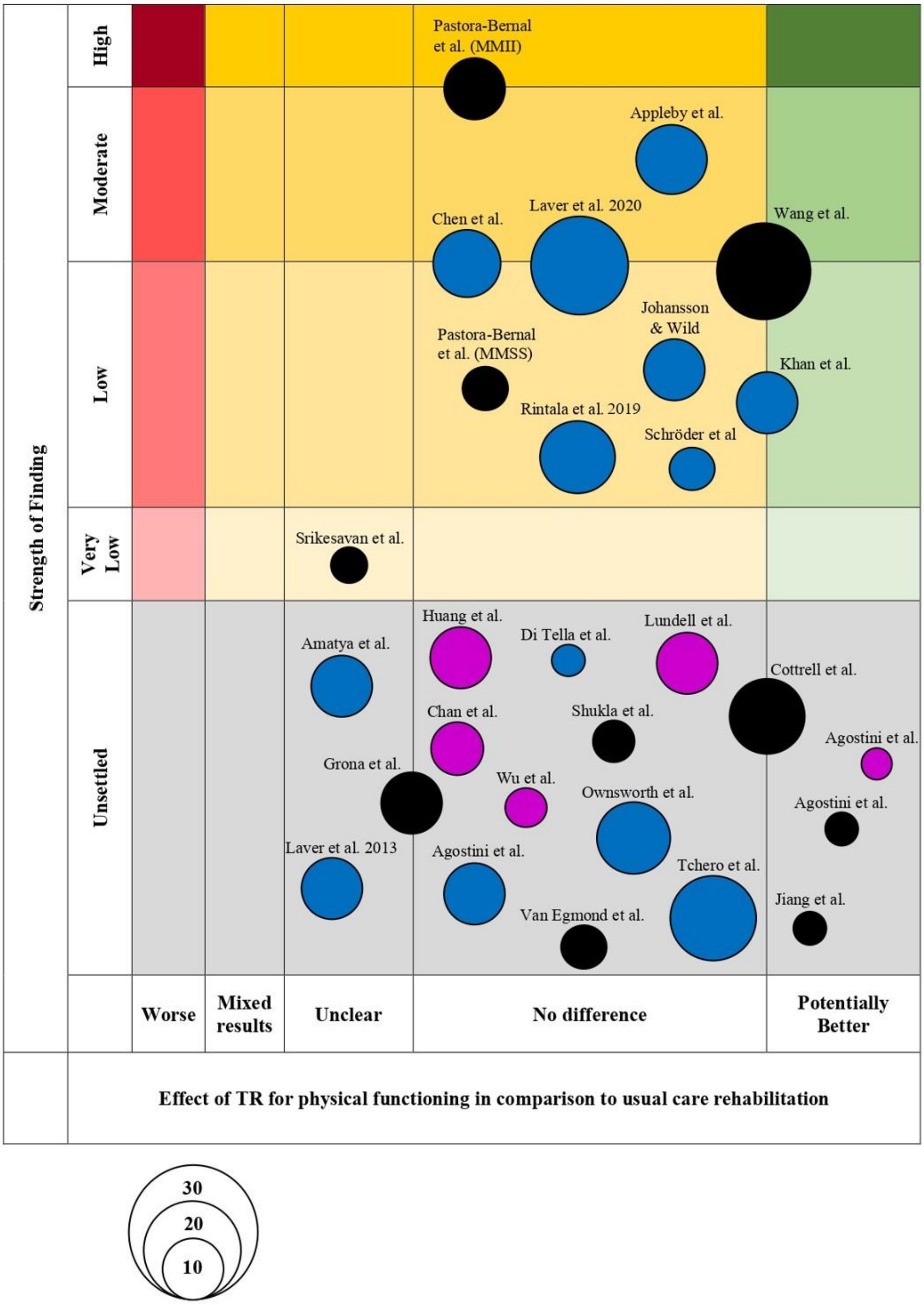

Figure 3. Evidence map of systematic reviews describing the effect of telerehabilitation

Blue bubble: patients with neurological conditions; Purple bubble: patients with cardiac and respiratory pathology; Black bubble: patients with musculoskeletal conditions.

On the x-axis, the studies are categorized based on the results obtained by each review, while on the y-axis they were classified based on the degree of recommendation (strength of the findings) proposed by each study. The size of the bubble is proportional to the number of studies included in each review (see Methods section).